

NAVAIR / GNSS StarLight

Peter Lobner, Updated 24 August 2021

1. Introduction

StarLight was part of Naval Air Systems Command's (NAVAIR's) "steerable balloon" program, which intended to develop a powered balloon with a stratospheric station-keeping capability, similar to a high altitude airship. The StarLight vehicle was a solar electric hybrid airship / unmanned aerial vehicle (UAV). It was developed under a Navy contract by the privately-held firm Global Near Space Services (GNSS) of Colorado Springs, CO, and Bye Aerospace (<https://byeaerospace.com>) of Denver, CO. It appears that GNSS was in business only between 2008 and 2012, after which it was acquired to form Enerbay – Near Space Systems (ENSS).



Artist's rendition of StarLight on station in the stratosphere.

Source: sUAS (2012)

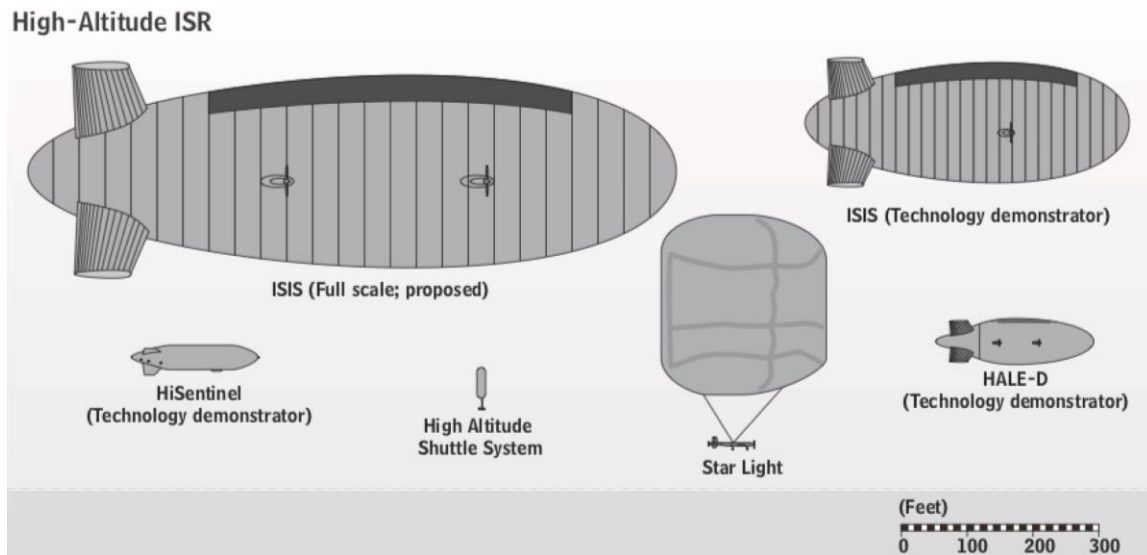
StarLight was a two-component vehicle comprised of a large balloon that provided the lift into the stratosphere, and a detachable fixed-wing, solar powered UAV that carried the flight controls and mission systems. At the end of the mission, the UAV separates from the balloon and semi-autonomously flies to a designated recovery site. This type of UAV was generically called a “payload recovery vehicle” (PRV). The balloon was expendable.

GNSS developed the StarLight stratospheric balloon and subcontracted to Bye Aerospace to design and build the detachable UAV, which they called a ‘stratospheric recovery vehicle’ (SRV)

2. StarLight mission

StarLight was one of two maneuverable stratospheric balloon projects funded by DoD and NASA in the period from 2002 to 2010. Unlike a conventional high altitude balloon system, the maneuverable balloon carried a suspended gondola with a solar-powered propulsion system to enable station keeping above a designated geo-location.

As shown in the following chart, the StarLight balloon was very large in comparison to some contemporary high altitude ISR airships (HiSentinel and HALE-D) and the other DoD two-component maneuverable balloon system (High-Altitude Shuttle System, HASS).



*Relative scale of StarLight and other U.S. high-altitude ISR airships.
Source: Adapted from Congressional Budget Office, Nov. 2011*

Candidate military missions for StarLight included intelligence, surveillance and reconnaissance (ISR) and communications. GNSS identified particular military applications such as border patrol, visual and thermal reconnaissance and forward air control. In addition, GNSS identified potential civil applications such as traffic control, pipeline and power line inspection, aerial law enforcement, forest fire detection and aerial photography.

NAVAIR and GNSS expected that flying hour costs of StarLight would be less than one-tenth the cost of current high altitude aircraft and UAS.

3. StarLight design

Like the HiSentinel stratospheric airships, the StarLight balloon is launched only partially inflated. The StarLight balloon system does not require a hangar and can launch out of an ISO container or from a ship. With a lift gas expansion ratio of more than 15:1 between sea level and the stratosphere, the balloon assumes its fully-inflated shape as it nears its operating altitude. At that point, the SRV flight controls are active and the solar powered propulsion system on the SRV moves the balloon to a designated geo-location and maintains station keeping there.

Operating altitude (flight ceiling, or pressure altitude) depends on the total mass of the SRV being carried by the balloon. StarLight altitude objectives were:

- 85,000 feet (16.1 miles, 25.9 km) with a 500 lb (227 kg) operational payload. This is an altitude surpassed only by ultra-high altitude free-floating balloons. At this altitude, StarLight had a line-of-sight radio-frequency (RF) range to the horizon of 356 miles (574 km) and an RF area coverage of almost 400,000 square miles (slightly more than 1 million square kilometers).
- 65,000 feet (12.5 miles, 19.8 km) with a 4,000 lb (1,814 kg) operational payload.

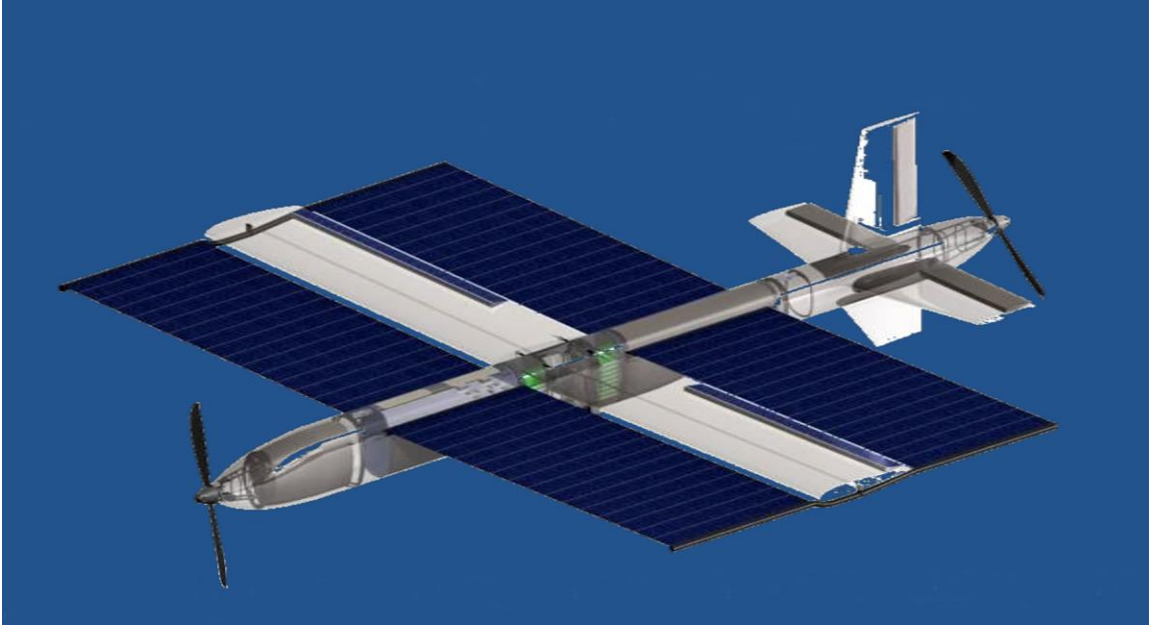


*The two-component StarLight system.
Source: DoD (2012)*

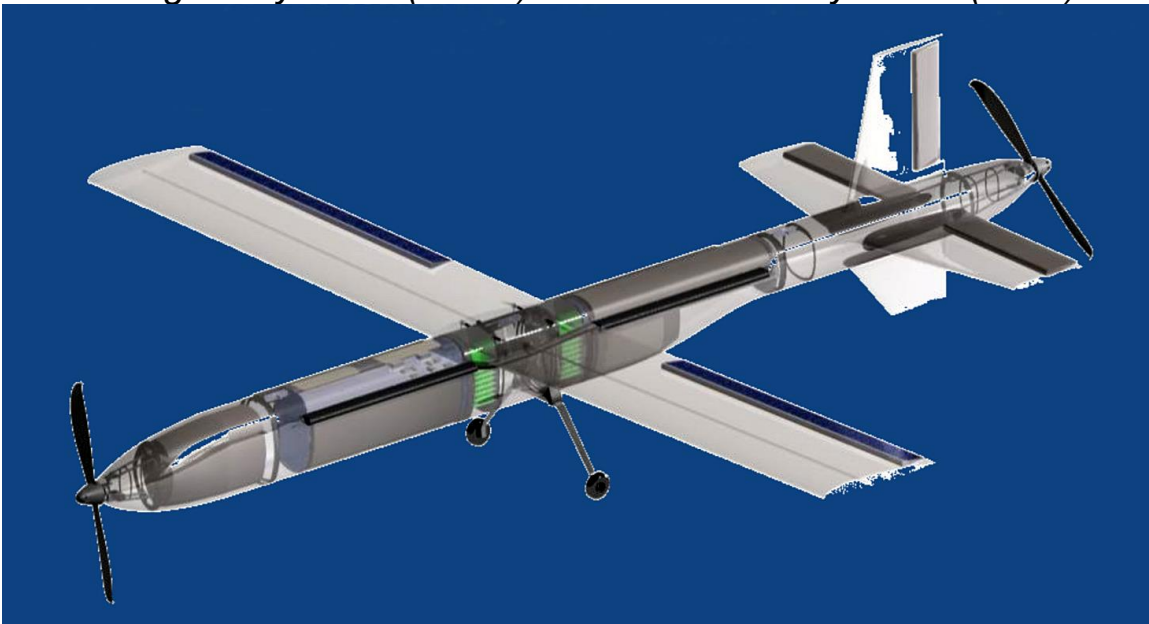
The SRV was designed with lightweight carbon composite structures, straight wings with deployable, flexible thin film photovoltaic arrays, and electric propulsion motors at the nose and tail of the fuselage.

StarLight was designed to stay on station for 3 to 4 months. At the end of the mission, the SRV separates from the balloon and flies under its own power with a range of more than 150 miles (241 miles), navigating semi-autonomously to a designated recovery site on the ground.

After recovery, the SRV can be maintained and equipped for its next mission with a new balloon.



General arrangement of the StarLight SRV (the Fly-Down Lower Stage) with its solar panels deployed on station (above) and retracted during the fly-down (below). Source: Enerbay - NSS (2015)



4. The subscale demonstrator

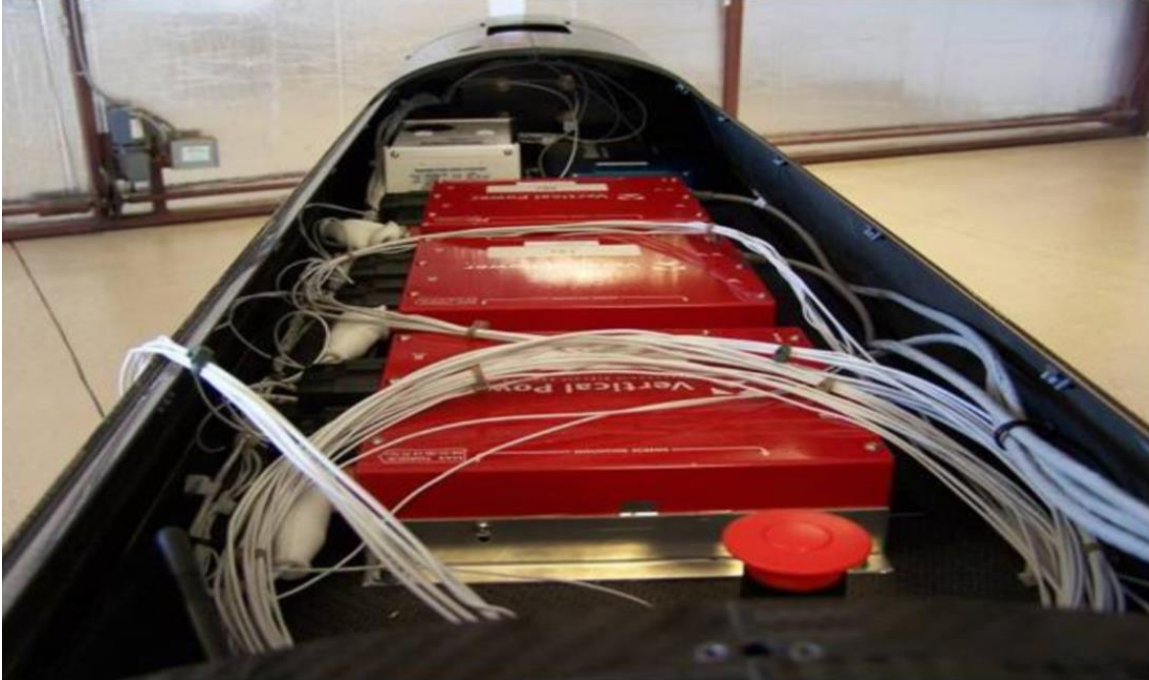
DoD reported, “GNSS received funding from the Navy’s Naval Air Warfare Center under the Long Endurance, Alternative Energy Stratospheric Airship Program to design and engineer a 40% subscale version of the system...”



Partially complete fuselage for the 40%-scale SRV demonstrator. Source: UAS Vision



Nose propeller on the partially complete fuselage for the 40%-scale SRV demonstrator. Source: ENSS



Battery packs on the partially complete fuselage for the 40%-scale SRV demonstrator. Source: ENSS

Flight demonstrations were planned with the objective of reaching an altitude of 65,000 feet (12.5 miles, 19.8 km) carrying the sub-scale SRV with a small payload. The sub-scale demonstrator was expected to validate the efficiency of the solar electric power system, vehicle performance and control at high altitude.

5. The end of NAVAIR's StarLight funding

NAVSTAR's StarLight contract with GNSS ended in October 2011 without a complete technology demonstrator being delivered. Project status at that time was:

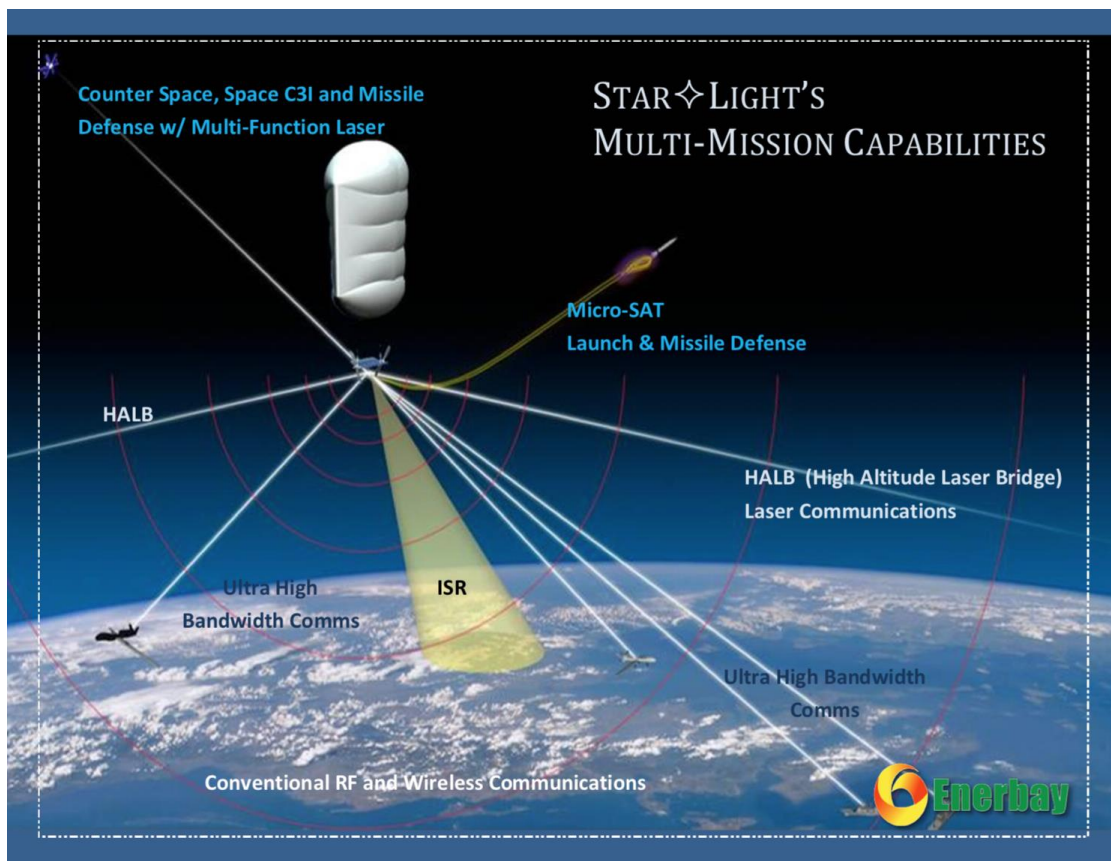
- The balloon envelope had completed its preliminary design review.
- The SRV completed critical design review, subsystems were assembled and tested, and the fuselage was largely complete. DoD estimated that overall SRV manufacturing was about 50% complete.

6. StarLight continues as part of the ENSS product line

After the NAVAIR StarLight contract ended, GNSS was acquired by Enerbay to form Enerbay – Near Space Systems (ENSS). The new firm offered three platforms in their “Star” portfolio of “affordable, persistent, wide-area communications and sensing” airships:

- **StarTower** was a tethered, hybrid aerostat designed to operate up to 10,000 ft (3,048 m).
- **StarShadow** was a free-flying, hybrid, unmanned airship, similar in shape to the StarTower and designed to operate between 5,000 and 15,000 ft (1,524 – 4,572 m).
- **StarLight** was their stratospheric platform with the same altitude performance originally intended by NAVAIR: up to 85,000 ft (25,908 m).

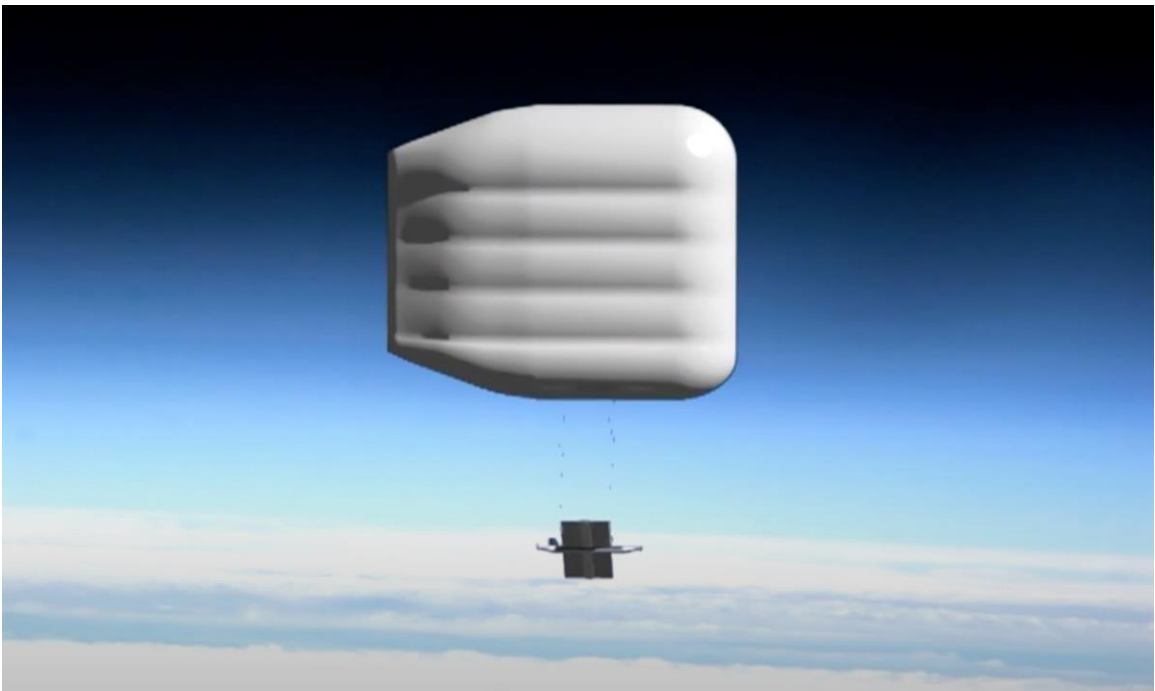
ENSS continued to promote StarLight mission capabilities shown in the following graphics.



Source: ENSS, circa 2015

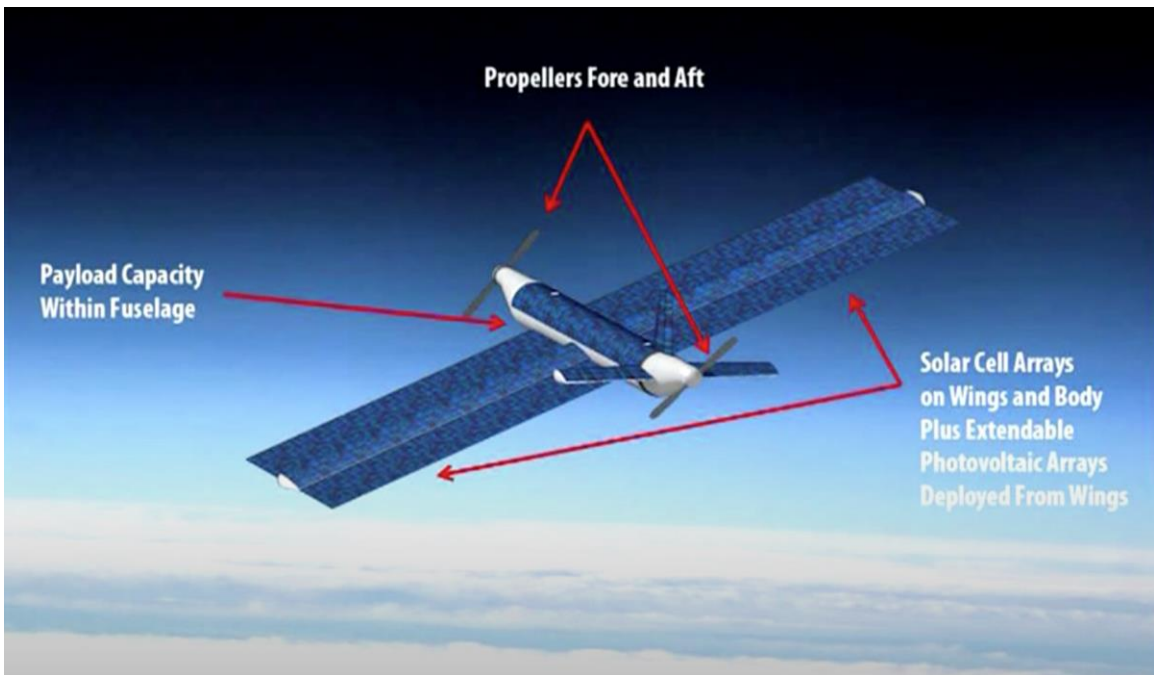


*Artist's renditions of StarLight on station in the stratosphere.
Source: ENSS, circa 2015*





StarLight SRV with wing solar panels stowed (during ascent & fly-down).



StarLight SRV with wing solar panels deployed on station.

Source, both graphics: ENSS, circa 2015

ENSS never completed the StarLight demonstrator or built a full-size stratospheric airship.

See my separate article on StarShadow for information on the ENSS medium altitude persistent communications and surveillance airship.

7. For more information

- John Keller, “Navy asks Near Space Systems to design a stratospheric airship as an alternative to satellite-based surveillance and communications, Military & Aerospace Electronics, 27 May 2010:
<https://www.militaryaerospace.com/defense-executive/article/16724445/navy-asks-near-space-systems-to-design-a-stratospheric-airship-as-an-alternative-to-satellitebased-surveillance-and-communications>
- “Recent Development Efforts for Military Airships,” Congressional Budget Office, November 2011:
<https://www.cbo.gov/sites/default/files/112th-congress-2011-2012/reports/11-01-Airships.pdf>
- “Solar Electric Hybrid Airship UAV Development Advances,” The Lighter Than Air Society, 3 March 2012:
<https://www.blimpinfo.com/uncategorized/solar-electric-hybrid-airship-uav-development-advances/>
- “Solar Electric Hybrid Airship,” UAS Vision:
<https://www.uasvision.com/2012/03/08/solar-electric-hybrid-airship/>
- Report to Congress, “Summary Report on DoD Funded Lighter-Than-Air Vehicles,” DoD Office of the Assistant Secretary of Defense for Research and Engineering, Appendix A-4, 1 November 2012:
<https://apps.dtic.mil/dtic/tr/fulltext/u2/a568211.pdf>
- “Enerbay – Near Space Systems (ENSS) – Providing Affordable, Persistent, Wide-Area Communications and Sensing,” marketing presentation circa 2015:
<http://www.enerbay.ca/wp-content/uploads/2015/09/Near-Earth-Systems.pdf>